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Question of the Day

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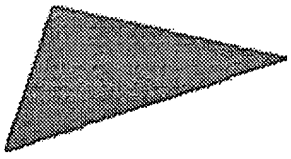
Each weekday, Marshall Brain and the HowStuffWorks Staff answer questions in the Question of the Day section of HowStuffWorks. The **Question Archive** lets you view hundreds of questions and answers. Click here to ask a question. Here is today's question!

Question

When I look at the description of some 3-D games, it says that the game uses Gouraud shading or texture mapping. What does that mean?

Answer

The vast majority of 3-D objects created for computer games are made up of **polygons**. A polygon is an area defined by lines. To have a polygon, you must have at least three lines.



A simple triangular polygon. Each point of the triangle is a vertex.

The lines connect a series of coordinates in the three-dimensional "space" the computer creates. The point where the lines connect in known as a **vertex**. Each vertex has **X**, **Y** and **Z** coordinates.

- X determines the position relative to right or left in the virtual space
- Y determines the position relative to top or bottom in the virtual space
- Z determines the position relative to front or back in the virtual space

Once each polygon has a set of vertices to define its shape, it needs information that tells it what to look like. There are four common ways to do this:

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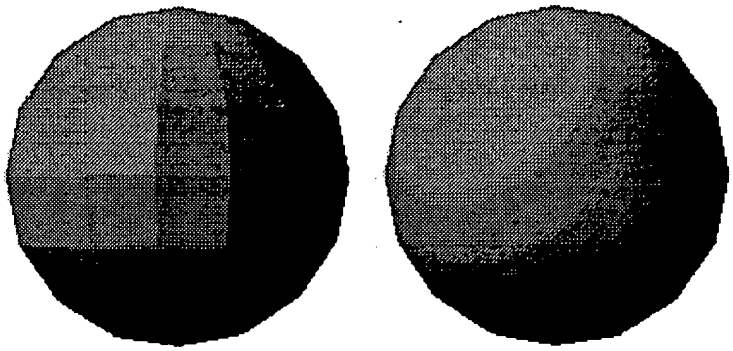
common ways to do this.

- Flat shading
- Gouraud shading
- Phong shading
- Texture mapping

Flat shading simply assigns a single color to a polygon. It is ver y simple and fast, but makes the object look very artificial. **Gouraud** shading is more involved. Colors are assigned to each vertex, then they are blended across the face of the polygon. Since each vertex is typically associated with at least three distinct polygons, this makes the object look natural instead of faceted. Look at this example:



Flat **Gouraud**

The same object with flat and Gouraud shading applied.

You will notice that the ball with Gouraud shading appears much smoother than the flat shaded one. But look closely at the outlines of the two balls. That is where you can tell that both balls have the exact same number of polygons!

A more complex version of shading, **Phong**, is rarely used in games. Where Gouraud shading interpolates colors by averaging between the vertices, Phong shading averages each pixel based on the colors of the pixels adjacent to it.

Another common technique for determining the appearance of a polygon is to use **texture mapping**. Think of texture mapping like wrapping a present. Each side of the box you are wrapping is a blank polygon. You could paint the box, but it would be very difficult to make it match all the designs on the wrapping paper. However, if you take the wrapping paper and tightly cover the box with it, you have completely transformed the box with just a little effort.

Texture mapping works the same way. Mapping requires the use of another image. This other image essentially is stretched over the object like a skin. Most video game consoles and computer graphics adapters contain a special chip and dedicated memory that

stores the special images used for texture mapping and applies them to each polygon on the fly. This allows games such as Tomb Raider to have incredibly detailed 3-D environments that you can interact with in real time.

Here are some interesting links:

- How 3-D Graphics Work
- Interactive shading applet!
- Programming using texture mapping
- SGI Report on texture mapping
- 3-D FX programming

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How did you like today's question?

- Fantastic - I will recommend it to others
- Very good - I learned a lot
- OK
- Not so hot - I didn't get much out of it
- Bad - this did nothing for me

Do you have any comments?

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DOCUMENT-IDENTIFIER: US 5708637 A
TITLE: Method and apparatus for enhanced writing and reading data

---------- KWIC ---------

DEPR:
The GPU 16, operative in accordance with the polygon drawing command from the
CPU 11, draws a polygon in the frame buffer 17 mapped in a two-dimensional
address space independent of the CPU 11. The GPU 16 performs flat shading in
which a polygon is drawn in the same color, Gouraud shading in which an
arbitrary color is designated for each vertex of the polygon to find the color
within the polygon, and texture mapping in which a texture as two-dimensional
picture data is applied to the polygon.

DEPR:
Specifically, when the flat shading is carried out in which a polygon of
triangle is drawn in the same color, the GTE 15 can perform coordinate
calculation at a maximum rate of approximately 1.5 million polygons per second.
When the Gouraud shading or the texture mapping is carried out, the GTE 15 can
perform coordinate calculation of approximately 5 hundred thousand polygons per
second at the maximum. Therefore, it is possible to reduce the load on the CPU
11 and to carry out high-speed coordinate calculation.

DOCUMENT-IDENTIFIER: US 6160557 A
TITLE: Method and apparatus providing efficient rasterization with data dependent adaptations

---------- KWIC ---------

BSPR:
There are numerous other schemes for computing colors, some of which involve more computationally intensive techniques. Common to these techniques is the interpolation of additional parameters for each pixel. In Phong shading, the normal, N, is interpolated for every pixel in the triangle. In texture mapping, S, T, and W coordinates are interpolated within the triangle in much the same way as R, G, and B are interpolated in Gouraud shading.